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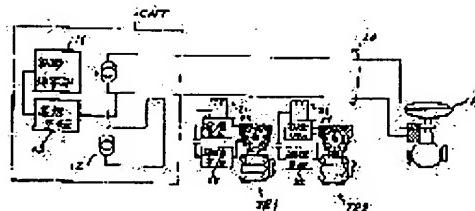
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## (54) ANALOG-DIGITAL COMMUNICATION EQUIPMENT

### (57)Abstract:

PURPOSE: To reduce number of transmission lines and to obtain the analog- digital communication equipment with high reliability by coupling electromagnetically each transmitter to a transmission line and supplying power and making digital communication through the transmission lines.

CONSTITUTION: A low frequency AC power supply means 12 of a controller CNT outputs an AC signal superimposed with an analog current signal to an actuator AT via a transmission line LO and an electromagnetic coupling means. A power supply means 23 of transmitters TR1, TR2 extracts the AC signal via an electromagnetic coupling means 21 to obtain operating power. Furthermore, a communication means 22 of the transmitters TR1, TR2 sends a digital signal being a high frequency pulse signal to the transmission line LO via the means 21 to make digital transmission reception with a communication means 13 of the controller CNT. Through the constitution above, number of transmission lines is reduced to save the wiring cost and the analog-digital communication equipment with high reliability is realized.



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## CLAIMS

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## [Claim(s)]

[Claim 1] The control device which outputs an analog-control signal, and the actuator which receives the control output from this control device through a transmission line, A low frequency AC-power-supply means to be the communication device equipped with the transmitter combined with said transmission line, to carry out an electromagnetic coupling to said transmission line, and to make the transmission line concerned superimpose an AC signal on said control unit side, The electromagnetic-coupling means which prepares the means of communications which combines with a transmission line and performs digital transmission and reception of a high frequency pulse signal, and carries out an electromagnetic coupling to said transmitter in a transmission line, The analog digital communication device characterized by establishing the means of communications which performs digital transmission and reception of a high frequency pulse signal through this electromagnetic-coupling means, and a power-source means to take out the low frequency AC signal on which the transmission line is overlapped through the electromagnetic-coupling means, and to obtain the operating power of the transmitter concerned.

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## DETAILED DESCRIPTION

## [Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the analog digital communication device equipped with the control device which outputs an analog-control signal, the actuator which receives the control output from this control device through a transmission line, and the transmitter combined with a transmission line in the location of arbitration in more detail in an industrial instrumentation etc. about the analog digital communication device which transmitted the analog signal and the digital signal according to the same transmission line.

[0002]

[Description of the Prior Art] Drawing 4 is the configuration conceptual diagram of the signal-transmission equipment performed between control units, such as for example, a distributed control unit (DCS) and a single loop-formation controller, and the various field devices (actuators, such as transmitters, such as temperature, a pressure, and differential pressure, and a bulb) connected to this.

[0003] From the transmitter TR currently installed in the field, the measurement signals PV, such as temperature, a pressure, and differential pressure, are sent to a control unit CNT through 2 line transmission line L1. Based on the inputted measurement signal, a control unit CNT performs a PID-control operation, and by making the result of an operation into a control output MV, it is constituted so that it may send to the actuators AT, such as a bulb, through another transmission line L2.

[0004]

[Problem(s) to be Solved by the Invention] When according to such a conventional system a transmission line is needed among one set of a control unit and a field device, respectively and it treats many I/O signals like a distributed control system, wiring costs including the facility construction pose a problem. Although the transmission line (field bus) of a multi-drop is examined in order to solve such a problem, there are the following troubles in this.

(a) It is necessary to consider all as digital communication, and if an ordinary actuator or an ordinary field device cannot be used upwards and one set of a field device breaks down, trouble will arise in the communication link between other field devices connected to Buss.

(b) It will become uncontrollable if the communication facility of actuators, such as a bulb, breaks down.

(c) Connection of the backup device at the time of abnormalities is difficult.

[0005] This invention was made in view of such a point, and it aims at offering a reliable analog digital communication device while it enables it to save wiring costs sharply, using an ordinary field device.

[0006]

[Means for Solving the Problem] The control unit with which this invention which attains such a purpose outputs an analog-control signal, The actuator which receives the control output from this control device through a transmission line, A low frequency AC-power-supply means to be the communication device equipped with the transmitter combined with said transmission line, to carry out an electromagnetic coupling to said transmission line, and to make the transmission line concerned

superimpose an AC signal on said control unit side, The electromagnetic-coupling means which prepares the means of communications which combines with a transmission line and performs digital transmission and reception of a high frequency pulse signal, and carries out an electromagnetic coupling to said transmitter in a transmission line, It is the analog digital communication device characterized by establishing the means of communications which performs digital transmission and reception of a high frequency pulse signal through this electromagnetic-coupling means, and a power-source means to take out the low frequency AC signal on which the transmission line is overlapped through the electromagnetic-coupling means, and to obtain the operating power of the transmitter concerned.

[0007]

[Function] On a transmission line, the analog signal sent to an actuator side from a control device, the RF pulse signal for the digital communication performed between a control device and a transmitter, and the low frequency AC signal used as the power by the side of each transmitter ride. The electromagnetic coupling of each transmitter is carried out to a transmission line in the location of arbitration, and while taking out a low frequency AC signal and obtaining own operating power, digital communication is performed between control-devices sides, such as transmission of a measurement signal, using a high frequency pulse signal.

[0008]

[Example] One example of this invention is explained to a detail using a drawing below. Drawing 1 is the configuration conceptual diagram showing one example of this invention. In drawing, CNT is a control unit, is a distributed control system or a single loop-formation controller, and has the PID-control operation part 11 inside. One transmission line to which L0 connects this control device CNT and a field device, and ATs are actuators, such as a bulb, and receive the control output MV of a 4-20mA analog current signal through a transmission line L0. TR1 and TR2 are the various field devices (transmitters, such as temperature, a pressure, and differential pressure) combined with a transmission line L0, and they are equipped with the electromagnetic-coupling means 21 so that it can join together to a transmission line L0 in the location of arbitration. As an electromagnetic-coupling means 21, a transformer is used, for example and it has composition which is combined in a clip-on format to the transmission line.

[0009] In a control unit CNT, the low frequency AC-power-supply means on which carry out the electromagnetic coupling of 12 to a transmission line L0, for example, the AC signal of about 14kHz low frequency is made to superimpose, and 13 are means of communications which combine with a transmission line L0, for example, perform digital transmission and reception of the high frequency pulse signal about 1Mbit/s. Although means of communications 13 is the example combined with the transmission line L0 through the capacitor here; you may be the configuration which carries out an electromagnetic coupling.

[0010] In each transmission lines TR1 and TR2, it is a power-source means for the means of communications to which 22 performs digital transmission and reception of a high frequency pulse signal through the electromagnetic-coupling means 21, and 23 to take out the low frequency AC signal on which the transmission line L0 is overlapped through the electromagnetic-coupling means 21, and to obtain the operating power of a transmitter. Drawing 2 is the configuration block Fig. of Transmitter TR showing a detail further. In this drawing, 31 is a sensor which detects temperature and a flow rate, and, as for the A/D converter from which 32 changes the signal from this sensor into a digital signal, and 33, memory and 34 are microprocessors. To the signal from a sensor 31, a predetermined operation is performed or this microprocessor performs control action of the various parts containing means of communications 22. The D/A converter which 35 changes the signal-processing result in a microprocessor 34 into an input/output interface, and changes 36 into an analog signal, and 37 are indicators which direct a signal-processing result with an analog value.

[0011] It connects with the microprocessor 34 through the internal bus, and means of communications 22 makes the signal-processing result outputted through an interface 35 the digital signal of a high frequency pulse signal, and through the electromagnetic-coupling means 21, it outputs to a transmission line L0, or it receives the digital signal of the high frequency pulse signal transmitted through the

electromagnetic-coupling means 21. Here, 38 is a filter circuit which extracts only a required RF pulse signal component, and 39 is a comparison means [ the predetermined electrical-potential-difference value E1 / amplitude / of a receiving pulse signal ].

[0012] Thus, actuation of the constituted equipment is explained below. Drawing 3 is the signal waveform diagram showing the change situation of a signal of riding on a transmission line L0. In a control unit CNT, the control operation part 11 sends the PID result of an operation (control output MV) to a transmission line L0 at Actuator AT side as an analog current signal IL which changes in 4-20mA. Actuator AT takes out the analog current signal IL through a low pass filter, and operates based on this analog signal. Transmission of such a control output (control input) MV is the same as that of the conventional transmission system, and its existing thing is [ Actuator AT ] usable.

[0013] The low frequency AC-power-supply means 12 of a control unit CNT is outputting AC signal AC of about 14kHz low frequency to the transmission line L0 through an electromagnetic-coupling means, and this AC signal AC becomes what was superimposed on the analog current signal IL mentioned above. Each transmitter TR was installed in the location of the arbitration of the field, and is combined with the transmission line L0 through the electromagnetic-coupling means 21. The power-source means 23 of each transmitter is stabilized, obtains the own operating voltage EO, and supplies the electrical potential difference to A/D converter 32, a microprocessor 34, D/A converter 35, and means-of-communications 22 grade while it makes the AC signal AC ejection of low frequency, and it rectification and smooth through the electromagnetic-coupling means 21. Here, A/D converter 32 changes the measurement signal PV from a sensor 31 into a digital signal, and a microprocessor 34 controls means of communications 22 while performing signal processing, such as a linear rise, using this digital signal.

[0014] The measurement signal by which signal processing was carried out by the microprocessor 34 is outputted to means of communications 22 through an interface 35, and high frequency pulse signal DA from which a current value changes in the direction of positive/negative in the shape of a pulse is sent out to a transmission line L0 through a capacitor from here, for example. It is formed by the data (the 1st bit the B1 to 8th bit) in which the address bit BA which shows flag bit BF, start bit BS, and transmitting origin, and measured value PV are shown as a gestalt of high frequency pulse signal DA, for example. A current value changes to a forward negative direction, and when it is a logical value "0", they enable it to transmit 1 byte of data by 8 bits here at the time of a logical value "1", as the bits B1-B8 which show data become changeless. In addition, the cutting tool of a predetermined number shall be transmitted as a digital signal if needed.

[0015] In a control device CNT, such a digital signal sent through the transmission line L0 is taken out by means of communications 13, and is used by the control operation part 11 if needed. When transmitting a command and data to Transmitter TR from a control-device CNT side, the address which shows a transmission place will be added to the digital signal transmitted from a control device. It is a case so that the parameter which sends the command which demands transmission of data to a transmitter side as a case where it is necessary to transmit a command or data to Transmitter TR from a control-device CNT side, or is used with a transmitter may be sent etc.

[0016] Thus, it shall be using the RF pulse signal from which a current value's changes in the direction of positive/negative in the shape of a pulse, that average shall serve as zero, and the digital communication performed between a control device CNT and a transmitter shall not have effect in transmission of AC signal AC of low frequency, and the analog current signal IL. In addition, although it assumed that a transmitter was combined with a transmission line L0 in the above-mentioned example, communication equipment which is called a handheld terminal is combined and it may be made to perform digital communication between this communication equipment and transmitter or between control devices in addition to such a field device. Moreover, AC signal AC for obtaining operating power and the frequency of digital signal DA are not limited to the frequency explained above that what is necessary is just to select the frequency which can be identified mutually. Moreover, you may make it the gestalt of a digital signal also take other specification.

[0017]

[Effect of the Invention] As explained to the detail above, while supplying power using the transmission line established in transmitting a control output to an actuator side from a control device according to this invention, it is what was made to perform digital communication, and the number of transmission lines can be lessened and wiring costs can be saved sharply. Moreover, an actuator can be operated by connecting the manual controller which outputs DC signal, even when failure arises to the device combined with a transmission line, while being able to operate with an analog direct current signal which changes in 4-20mA and being able to use an ordinary actuator.

[0018] Moreover, while a transmitter can combine a transmitter with a transmission line in the location of arbitration by having considered as the configuration which carries out an electromagnetic coupling to a transmission line, the problem of multipoint touch-down does not occur among other field devices combined with transmission lines, such as an actuator. Therefore, it is reliable and an analog digital communication device with the easy shift to a field bus can be realized.

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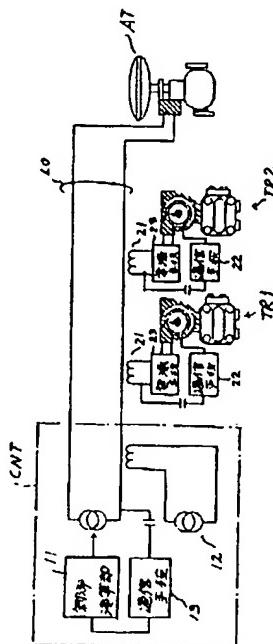
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(54)【発明の名称】 アナログ・デジタル通信装置

(57)【要約】 (修正有)

【目的】伝送路の数を少なくして配線費用を節約すると共に、信頼性が高く、フィールドバスへの移行を容易とする。

【構成】制御装置側に、伝送路L0に電磁結合し、その伝送路に交流信号を重畳させる低周波交流電源手段12と、伝送路に結合し高周波パルス信号のデジタル送受信を行う通信手段13とを設け、伝送器TR1, 2に、伝送路に電磁結合する電磁結合手段21と、この電磁結合手段を介して高周波パルス信号のデジタル送受信を行う通信手段と、電磁結合手段を介して伝送路に重畳されている低周波交流信号を取り出し、その伝送器の動作電力を得る電源手段23とを設けて構成される。



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## 【特許請求の範囲】

【請求項1】 アナログ制御信号を出力する制御装置と、この制御装置からの制御出力を伝送路を介して受けるアクチュエータと、前記伝送路に結合する伝送器とを備えた通信装置であって、

前記制御装置側に、前記伝送路に電磁結合し当該伝送路に交流信号を重複させる低周波交流電源手段と、

伝送路に結合し高周波パルス信号のデジタル送受信を行う通信手段とを設け、

前記伝送器に、伝送路に電磁結合する電磁結合手段と、この電磁結合手段を介して高周波パルス信号のデジタル送受信を行う通信手段と、

電磁結合手段を介して伝送路に重複されている低周波交流信号を取り出し当該伝送器の動作電力を得る電源手段とを設けたことを特徴とするアナログ・ディジタル通信装置。

## 【発明の詳細な説明】

## 【0001】

【産業上の利用分野】 本発明は、工業計測などにおいて、アナログ信号とデジタル信号とを同一の伝送路により伝送するようにしたアナログ・ディジタル通信装置に関し、更に詳しくは、アナログ制御信号を出力する制御装置と、この制御装置からの制御出力を伝送路を介して受けるアクチュエータと、伝送路に任意の位置で結合する伝送器とを備えたアナログ・ディジタル通信装置に関する。

## 【0002】

【從来の技術】 図4は、例えば分散形制御装置(DCS)やシングルループ・コントローラ等の制御装置と、これに接続されている各種フィールド機器(温度・圧力・差圧等の伝送器やバルブ等のアクチュエータ)との間で行われる信号伝送装置の構成概念図である。

【0003】 フィールドに設置されている伝送器TRからは、例えば2線伝送路L1を介して、温度・圧力・差圧等の測定信号PVが制御装置CNTに送られる。制御装置CNTは、入力した測定信号に基づき、例えば、PID制御演算を行い、その演算結果を制御出力MVとして、もう一つの伝送路L2を介してバルブ等のアクチュエータATに送るように構成されている。

## 【0004】

【発明が解決しようとする課題】 この様な從来のシステムによれば、制御装置と1台のフィールド機器との間でそれぞれ伝送路が必要となり、分散形制御システムのように多数の入出力信号を扱うような場合、その工事を含む配線費用が問題となる。この様な問題を解決するために、マルチドロップ方式の伝送路(フィールドバス)が検討されているが、これには以下の問題点がある。

(a) 全てデジタル通信とする必要があり、従来のアクチュエータやフィールド機器を使用することできな

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い上に、1台のフィールド機器が故障すると、バスに接続されている他のフィールド機器との間での通信に支障が生ずる。

(b) バルブ等のアクチュエータの通信機能が故障すると、制御が不可能となる。

(c) 異常時のバックアップ機器の接続が困難である。

【0005】 本発明は、この様な点に鑑みてなされたもので、在來のフィールド機器を使用しながら配線費用を大幅に節約できるようにするとともに、信頼性の高いアナログ・ディジタル通信装置を提供すること目的とする。

## 【0006】

【課題を解決するための手段】 この様な目的を達成する本発明は、アナログ制御信号を出力する制御装置と、この制御装置からの制御出力を伝送路を介して受けるアクチュエータと、前記伝送路に結合する伝送器とを備えた通信装置であって、前記制御装置側に、前記伝送路に電磁結合し当該伝送路に交流信号を重複させる低周波交流電源手段と、伝送路に結合し高周波パルス信号のデジタル送受信を行う通信手段とを設け、前記伝送器に、伝送路に電磁結合する電磁結合手段と、この電磁結合手段を介して高周波パルス信号のデジタル送受信を行う通信手段と、電磁結合手段を介して伝送路に重複されている低周波交流信号を取り出し当該伝送器の動作電力を得る電源手段とを設けたことを特徴とするアナログ・ディジタル通信装置である。

## 【0007】

【作用】 伝送路上には、制御装置からアクチュエータ側へ送られるアナログ信号と、制御装置と伝送器との間で行われるデジタル通信のための高周波パルス信号と、各伝送器側への電力となる低周波交流信号とが乗る。各伝送器は、伝送路に対して任意の位置で電磁結合し、低周波交流信号を取り出して自身の動作電力を得るとともに、高周波パルス信号を用いて例えば測定信号の伝送など制御装置側との間でデジタル通信を実行する。

## 【0008】

【実施例】 以下図面を用いて本発明の一実施例を詳細に説明する。図1は、本発明の一実施例を示す構成概念図である。図において、CNTは制御装置で、分散形制御システムあるいはシングルループ・コントローラであり、内部には例えばPID制御演算部11を有している。LOはこの制御装置CNTとフィールド機器とを結ぶ一つの伝送路、ATはバルブ等のアクチュエータで、伝送路LOを介して、例えば、4~20mAのアナログ電流信号の制御出力MVを受ける。TR1、TR2は伝送路LOに結合する各種フィールド機器(温度・圧力・差圧等の伝送器)で、伝送路LOに対して任意の位置で結合できるように、電磁結合手段21を備えている。電磁結合手段21としては、例えばトランクが用いられ、伝送線路に対してクリップオン形式で結合するような構

成となっている。

【0009】制御装置CNTにおいて、12は伝送路L0に電磁結合し例えれば14KHz程度の低周波の交流信号を重畳させる低周波交流電源手段、13は伝送路L0に結合し、例えれば、1Mbit/s程度の高周波パルス信号のデジタル送受信を行う通信手段である。ここでは、通信手段13はコンデンサを介して伝送路L0に結合した例であるが、電磁結合する構成であってよい。

【0010】各伝送路TR1、TR2において、22は電磁結合手段21を介して高周波パルス信号のデジタル送受信を行う通信手段、23は電磁結合手段21を介して伝送路L0に重畳されている低周波交流信号を取り出し、伝送器の動作電力を得る電源手段である。図2は、伝送器TRの更に詳細を示す構成ブロック図である。この図において、31は温度や流量を検出するセンサであり、32はこのセンサからの信号をデジタル信号に変換するA/D変換器、33はメモリ、34はマイクロプロセッサである。このマイクロプロセッサは、センサ31からの信号に対して所定の演算を行つたり、通信手段22を含む各種部分の制御動作を行うものである。35は入出力インターフェース、36はマイクロプロセッサ34での信号処理結果をアナログ信号に変換するD/A変換器、37は信号処理結果をアナログ値で指示する指示計である。

【0011】通信手段22は、マイクロプロセッサ34に内部バスを介して接続されており、インターフェース35を介して出力される信号処理結果を、高周波パルス信号のデジタル信号とし、電磁結合手段21を介して伝送路L0に出力したり、電磁結合手段21を介して伝送された高周波パルス信号のデジタル信号を付したりする。ここで、38は必要な高周波パルス信号だけを抽出するフィルタ回路であり、39は受信パルス信号の振幅を所定の電圧値E1と比較する比較器である。

【0012】このように構成した装置の動作を図3に説明する。図3は、伝送路L0上に乘る信号の変化状況を示す信号波形図である。制御装置CNTにおいて制御演算部11は、PID演算結果(制御出力MV)を伝送路L0に、例えれば4~20mAの範囲で変化する「ログ電流信号IL」としてアクチュエータAT側に付す。アクチュエータATは、アナログ電流信号ILだけをローパスフィルターを介して取り出し、このアナログ信号に基づいて動作する。この様な制御出力(ドライバ)MVの伝送は、従来の伝送方式と同様であり、ドライバエクチュエータATは既存のものが使用可能となっている。

【0013】制御装置CNTの低周波交流電源は、伝送路L0に電磁結合手段を介して、例えれば14KHz程度の低周波数の交流信号ACを出力して、この交流信号ACは前述したアナログ電流信号ILに重畳

したものとなる。各伝送器TRは、フィールドの任意の場所に設置され、伝送路L0に電磁結合手段21を介して結合している。各伝送器の電源手段23は、電磁結合手段21を介して低周波数の交流信号ACを取り出し、それを整流・平滑すると共に、安定化して自身の動作電圧EOを得、その電圧をA/D変換器32、マイクロプロセッサ34、D/A変換器35、通信手段22等に供給する。ここで、A/D変換器32は、センサ31からの測定信号PVをデジタル信号に変換し、マイクロプロセッサ34はこのデジタル信号を用いて、例えれば、リニアライズ等の信号処理を行うと共に、通信手段22を制御する。

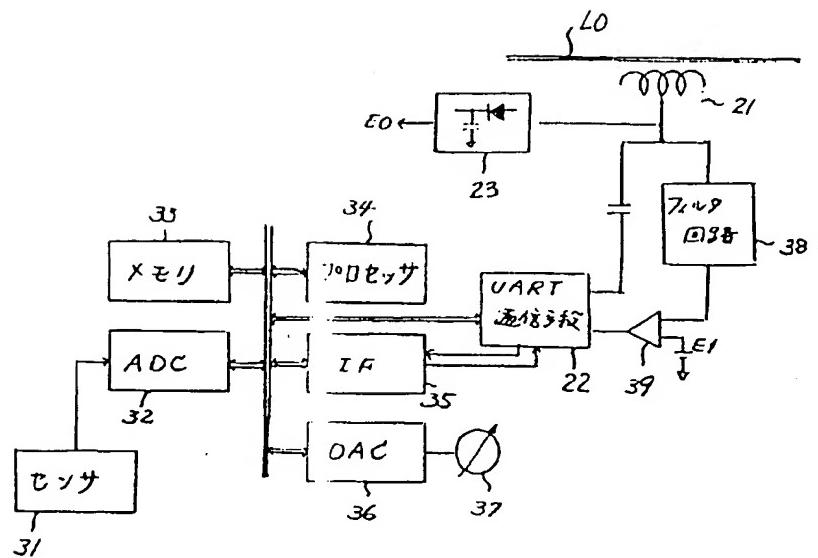
【0014】マイクロプロセッサ34で信号処理された測定信号は、インターフェース35を介して通信手段22に出力され、ここから、例えれば、パルス状に正負方向に電流値が変化する高周波パルス信号DAがコンデンサを介して伝送路L0に送り出される。高周波パルス信号DAの形態としては、例えれば、フラグビットBF、スタートビットBS、送信元を示すアドレスビットBA、測定値PVを示すデータ(第1ビットB1から第8ビット)で形成される。データを示しているビットB1~B8は、ここでは、論理値「1」のときは正負の方向に電流値が変化し、論理値「0」のときは、無変化となるようにして、8ビットで1バイトのデータを送信できるようしている。なお、必要に応じて、所定数のバイトがデジタル信号として伝送されるものとする。

【0015】制御装置CNTにおいて、伝送路L0を介して送られたこの様なデジタル信号は、通信手段13により取り出され、必要に応じて制御演算部11で利用される。制御装置CNT側から伝送器TRにコマンドやデータを送信するような場合は、制御装置から送信されるデジタル信号には、送信先を示すアドレス等が付加されることとなる。制御装置CNT側から伝送器TRにコマンドあるいはデータを送信する必要があるケースとしては、伝送器側にデータの送信を要請するコマンドを送ったり、伝送器で用いるパラメータを送る場合等である。

【0016】この様に制御装置CNTと伝送器との間で行われるデジタル通信は、パルス状に正負方向に電流値が変化する高周波パルス信号を用いることで、その平均値が零となり、低周波数の交流信号ACやアナログ電流信号ILの伝送には影響のないものとしている。なお、上記の実施例では、伝送路L0には伝送器が結合されることを想定したが、この様なフィールド機器以外に、例えればハンドヘルドターミナルと呼ばれるような通信機器を結合させ、この通信機器と伝送器との間あるいは制御装置との間でデジタル通信を行うようにしてもよい。また、動作電力を得るための交流信号ACや、デジタル信号DAの周波数は、互いに識別できるような周波数を選定すればよく、上記に説明した周波数に限定



【図2】



【図4】

